We claim:

1. A method for producing a nanocomposite film comprising the step of:

fabricating a plurality of alternating layers comprising a nanoparticle layer and a crosslinker layer onto a substrate.

2. The method of claim 1, wherein said plurality of alternating layers further comprise at least one polymer layer.

3. The method of claim 1, wherein said plurality of alternating layers further comprise at least one polymer layer crosslinked to said crosslinker layer.

4. The method of claim 1, further comprising the steps of:

contacting said nanocomposite film with an abrasion resistant compliant resin; and

curing said abrasion resistant compliant resin on said nanocomposite film;

wherein said resin is selected from the group consisting of thermosetting resins, photosetting resins, phenolformaldehyde, phenol resins, epoxy resins, polysiloxane resins, polyurethane, and poly(etherurethane) resins.

5. The method of claim 1, further comprising the steps of:

contacting said nanocomposite film with an abrasion resistant compliant resin;

curing said abrasion resistant compliant resin on said nanocomposite film; and

removing said resinous coating from said substrate;

wherein said resin is selected from the group consisting of thermosetting resins, photosetting resins, phenolformaldehyde, phenol resins, epoxy resins, polysiloxane resins, and poly(etherurethane) resins.

6. The method of claim 1, wherein said nanoparticle layer comprises nanoparticles selected from the group consisting of metallic nanoparticles, semiconducting nanoparticles, magnetic nanoparticles, ceramic nanoparticles, and dielectric nanoparticles or any combination thereof.

7. The method of claim 1, wherein said substrate is selected from the group consisting of a glass slide, single crystal silicon, polycarbonate, kapton, polyethylene rigid polymer

materials, flexible polymer materials, ceramics, metal surfaces, etched surfaces, functionalized surfaces, and non-functionalized surfaces.

8. The method of claim 1, wherein said crosslinker layer comprises a crosslinker that has at least two functional groups wherein said functional groups are selected from the group consisting of hydroxyl groups, amino groups, carboxyl groups, carboxylic acid anhydride groups, mercapto groups, hydrosilicon groups and any combination thereof.

9. The method of claim 8, wherein said crosslinker is mercaptoethanol.

10. The method of claim 1, wherein said nanoparticle is selected from the group consisting of a gold nanoparticle, a gold alloy nanoparticle, a gold core shell nanoparticle, a silver nanoparticle, a silver alloy nanoparticle, a silver core shell nanoparticle, a platinum nanoparticle, a platinum alloy nanoparticle, a platinum core shell nanoparticle, a palladium nanoparticle, a palladium alloy nanoparticle, a palladium core shell nanoparticle, a copper nanoparticle, a copper alloy nanoparticle, a copper core shell nanoparticle, and any combination thereof.

11. The method of claim 1, wherein said nanoparticle comprises a diameter in the range of about 1 nm to about 1000 nm.

12. The method of claim 2, wherein said polymer is an organosilane.

13. The method of claim 2, wherein said polymer is selected from the group consisting of poly(etherurethane) and poly(dimethyl-co-methylhydrido-co-3-cyanopropyl, methyl) siloxane.

14. A method for transferring nanoparticle layers from a substrate onto a film comprising the steps of:

providing a nanocomposite film comprising at least one nanoparticle layer and at least one crosslinker layer on a substrate;

contacting said nanocomposite film with an abrasion resistant compliant resin; and

curing said abrasion resistant compliant resin on said nanocomposite film.

15. The method of claim 14, further comprising the step of removing said resinous coating from said substrate by the method selected from the group consisting of chemical dissolution of the substrate, mechanical removal wherein said polymer and said substrate exhibit a broad range in coefficient of thermal expansions, by subambient removal wherein said polymer and said substrate exhibit a broad range in coefficient of thermal expansions, by using a chemical adhesive primer, by using heat, and by using energy via UV or IR irradiation.

16. The method of claim 14, wherein said abrasion resistant resin comprises functional groups capable of reacting with nanoparticle ligands.

17. The method of claim 14, wherein the pattern and properties of said nanoparticle remain intact following said transfer.

18. The method of claim 14, wherein said resin is selected from the group consisting of thermosetting resins, photosetting resins, phenolformaldehyde, phenol resins, epoxy resins, polysiloxane resins, polyurethane, and poly(etherurethane) resins.

19. A method for producing a nanocomposite film comprising the steps of:

providing a substrate comprising a primary layer of nanoparticles; and

immersing said substrate into a nanoparticle growth solution wherein said growth solution comprises a metal corresponding to said nanoparticle and a reducing agent wherein said reducing agent reduces said metal onto the surface of said primary layer of nanoparticles.

20. The method of claim 19, further comprising the steps of:

contacting said nanocomposite film with an abrasion resistant compliant resin; and

curing said abrasion resistant compliant resin on said nanocomposite film.

21. A nanocomposite film comprising at least one nanoparticle layer and at least one crosslinker layer adjacent to said nanoparticle layer.

22. The nanocomposite film of claim 21, further comprising at least one polymer layer.

23. The nanocomposite film of claim 22, wherein said at least one polymer layer is crosslinked to said crosslinker layer.

24. The nanocomposite film of claim 21, wherein said nanoparticle layer comprises nanoparticles selected from the group consisting of metallic nanoparticles, semiconducting nanoparticles, magnetic nanoparticles, ceramic nanoparticles, and dielectric nanoparticles or any combination thereof.

25. The nanocomposite film of claim 21, further comprising a substrate adjacent to said nanoparticle layer wherein said substrate is selected from the group consisting of a glass slide, single crystal silicon, polycarbonate, kapton, polyethylene rigid polymer materials, flexible polymer materials, ceramics, metal surfaces, etched surfaces, functionalized surfaces, and non-functionalized surfaces.

26. The nanocomposite film of claim 21, wherein said crosslinker layer comprises a crosslinker that has at least two functional groups sites wherein said functional groups are selected from the group consisting of hydroxyl group, amino group, carboxyl group, carboxylic acid anhydride group, mercapto group, hydrosilicon group, and any combination thereof.

27. The nanocomposite film of claim 26, wherein said crosslinker is mercarptoethanol.

28. The nanocomposite film of claim 21, wherein said nanoparticle is selected from the group consisting of a gold nanoparticle, a gold alloy nanoparticle, a gold core shell nanoparticle, a silver nanoparticle, a silver alloy nanoparticle, a silver core shell nanoparticle, a platinum nanoparticle, a platinum alloy nanoparticle, a platinum core shell nanoparticle, a palladium nanoparticle, a palladium alloy nanoparticle, a palladium core shell nanoparticle, a copper nanoparticle, a copper alloy nanoparticle, a copper core shell nanoparticle, and any combination thereof.

29. The nanocomposite film of claim 21, wherein said polymer layer is an organosilane.

30. The nanocomposite film of claim 21, wherein said polymer layer comprises a polymer selected from the group consisting of poly(etherurethane) and poly(dimethyl-co-methylhydrido-co-3-cyanopropyl, methyl) siloxane.

31. The nanocomposite film of claim 21, wherein said film comprises one or more properties selected from the group consisting of a Young's modulus in the range of about 0.01 MPa to about 200 MPa, an electrical bulk conductivity in the range of about $1 \times 10^{-3}\ \Omega^{-1}\ m^{-1}$ to about $7 \times 10^{6}\ \Omega^{-1}\ m^{-1}$, an electrical sheet resistance in the range of about 0.1 Ω/sq to about 200 Ω/sq, and a thermal conductivity in the range of about 0.1 W/m °K to about 100 W/m °K.

32. The nanocomposite film of claim 21, wherein said film is an electrically conducting electrode having a Young's Modulus in the range of about 0.01 MPa to about 200 MPa and an electrical sheet resistance in the range of about 0.1 Ω/sq to about 200 Ω/sq.

33. The nanocomposite film of claim 21, wherein said film is an electrically conducting electrode having a Young's Modulus of about 20 MPa and an electrical sheet resistance of about 10 Ω/sq.

34. The nanocomposite film of claim 32, wherein said film is free standing.

35. The nanocomposite film of claim 21, wherein said film is a thermally conducting material having a Young's Modulus in the range of about 0.01 MPa to about 200 MPa and a thermal conductivity in the range of about 0.1 W/m °K to about 100 W/m °K.

36. The nanocomposite film of claim 21, wherein said film is a thermally conducting material comprising a Young's Modulus of about 0.2 MPa and a thermal conductivity of about 2 W/m °K.

37. The nanocomposite film of claim 21, wherein said film is an optically reflecting material comprising a Young's Modulus in the range of about 0.01 MPa to about 200 MPa and an optical reflection coefficient in the range of about 1 % to about 97 %.

38. The nanocomposite film of claim 21, wherein said film is an optically reflecting material comprising a Young's Modulus of about 10 MPa and an optical reflection coefficient about 65 % at a wavelength of about 633 nm.

39. A strain sensor comprising a plurality of alternating layers comprising a nanoparticle layer and a crosslinker layer.

40. The strain sensor of claim 39, wherein said plurality of alternating layers further comprise at least one polymer layer.

41. The strain sensor of claim 39, wherein said plurality of alternating layers further comprise at least one polymer layer crosslinked to said crosslinker.

42. The strain sensor of claim 39, wherein said strain sensor comprises one or more properties selected from the group consisting of a Young's modulus in the range of about 0.01 MPa to about 200 MPa, an electrical bulk conductivity in the range of about $1 \times 10^{-3}\ \Omega^{-1}\ m^{-1}$ to about $7 \times 10^{6}\ \Omega^{-1}\ m^{-1}$, an electrical sheet resistance in the range of about 0.1 Ω/sq to about 200 Ω/sq, and a thermal conductivity in the range of about 0.1 W/m ^{o}K to about 100 W/m ^{o}K.

43. The strain sensor of claim 39, wherein said strain sensor comprises a Young's Modulus of about 20 MPa and an electrical sheet resistance of about 10 Ω/sq.

44. A flexible electrical interconnect comprising a plurality of alternating layers comprising a nanoparticle layer and a crosslinker layer.

45. The flexible electrical interconnect of claim 44, wherein said plurality of alternating layers further comprise at least one polymer layer.

46. The flexible electrical interconnect of claim 44, wherein said plurality of alternating layers further comprise at least one polymer layer crosslinked to said crosslinker.

47. The flexible electrical interconnect of claim 44, wherein said flexible interconnect comprises one or more properties selected from the group consisting of a Young's modulus in the range of about 0.01 MPa to about 200 MPa, an electrical bulk conductivity in the range of about $1 \times 10^{-3}\ \Omega^{-1}\ m^{-1}$ to about $7 \times 10^{6}\ \Omega^{-1}\ m^{-1}$, an electrical sheet resistance in the range of about 0.1 Ω/sq to about 200 Ω/sq, and a thermal conductivity in the range of about 0.1 W/m °K to about 100 W/m °K.

48. The flexible electrical interconnect of claim 44, wherein said flexible electrical interconnect comprises a Young's Modulus of about 100 MPa and an electrical sheet resistance of about 10 Ω/sq.